Independent Verification And Validation (IV & V)

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Agenda

- Background & Definitions
- IV & V Functions & Perspectives
- IV & V Process
- 9 Elements of Complete IV & V
- Methodology
- Software Criticality Analysis
- Software Requirements Inspection
- Conclusions

Purpose

- Enhances the probability that software:
  - will be released on time
  - will be cost effective
  - will enhance success
  - will be released with fewer software erro
  - performs correctly

Background

- Genesis: Early Space & Missile Programs

- Motivation: “No Second Chance” Performance

- Failure Impact: Loss of Human Life / National Pride

- Twist: Independence of Evaluator

IV & V Definition

- “Systematic evaluation of software produ
- activities by an agency that is not respon
- developing the product or performing th
- being evaluated.” [para 3.23]

- Per MIL-STD-498/IEEE-1498

Verification vs... Validation

- Difference is in the level of detail and critica of software to be tested and analyzed

Verification Definition

- Process to determine if products in each ph software developments are consistent with res to the previous phase

- Test and analysis are done at the lower tier (module)

Verification Focus

- Software requirements are complete, correc consistent with respect to system specification
- Interface requirements (Hardware vs. Softw
- Design verification vs. requirements
- Code verification vs. the design

Verification Elements

- Analytical activities ensuring the Software Requirements Specification (SRS) reflects allo system requirements
- Evaluation activities ensuring the Compute Configuration Item (CSCI) meets SRS requiren each level of detail
- Informal testing at the CSCI and componen

Verification Elements (continued)

- Ensuring software products, processes, serv documents conform to specified requirements

- Documenting verification methods, cases, e and corrective actions

- Assigning a criticality value for each requir and each software unit

Validation Definition

- Process to determine if the fully integrated software operated correctly, completely, and co with system specifications and requirements

- Test and analysis are done at the “system” l

Validation Focus

- Ensuring the system requirements have bee

- Ensuring the executable code is derived f
source code

- Ensuring that the integrated code meets
system requirements

Validation Elements

- Analytical and evaluation activities ensuring
system requirements have been addressed
- Testing at the fully integrated computer sw
- Ensuring software products, processes, ser
documents conform to specified requirements
- Documenting verification methods, cases, e
and corrective actions

IV & V Functions

- Independently tests performance
- Measure satisfaction of requirements
- Independent criticality analysis
- Defect impact, detection & removal
- Compliments prime contractor’s activities

Doesn’t replace prime’s

IV & V Perspectives

	IV & V Agent	Developer
Product	Push to Failure	Pull to Success
Mindset	Pessimistic	Optimistic
Testing	Inherently Good	Necessary Evil
Allegiance	Customer	Contractor

IV & V Process

1) Determine need
2) Establish scope
3) Estimate costs
4) Select IV & V agent
5) Conduct IV & V

IV & V Process (continued)

Need Determination

- Early EMD
- Impact of Undetected errors
  - Loss of life
  - Personnel injury
  - Mission failure
  - Catastrophic equipment loss
- Assess degree of technical risk

Scope

- Tailored to criticality of SW
- Use system req spec & interface req spec
- Benefit must exceed cost

IV & V Process (continued)

Cost Estimation

- Cost varies by each effort
- Typically, 10 – 50% of development cost
- > 50% for catastrophic effects on new technology

Selection of Agent

- Autonomous operations
- Independent Analysis
- Unbiased decision making
- Strong experience & solid methodology
- If in-house ……. Must be truly independent

9 Elements of a Complete IV & V Effort

1) Review SW developer's methodologies
2) Requirements identification & allocation
3) Test matrix development
4) Verification tests
5) Validation tests
6) Quality control
7) Configuration management
8) Data management
9) Code Execution

9 Elements of a Complete IV & V Effort (cont)

1) Review of the SW developers methodologies
   - Evaluate robustness of developers process
2) Requirements identification & allocation
   - Analyze all spec & req documents
   - Enter identified SW requirements into database
   - Perform a requirements allocation flow-down

9 Elements of a Complete IV & V Effort (cont)

3) Keys to test matrix development

- For each identified SW requirement, develop a test requirement and determine a test method and success criteria
- Record the pass/fail results for each test
- Use the same database for all SW test activities

9 Elements of a Complete IV & V Effort (cont)

4) Keys to verification tests

- Verify that SW requirements are complete, correct and consistent with respect to the system specifications
- Verify the physical, external interfaces of SW versus the identified requirements and system hardware
- Verify the design versus identified requirements

9 Elements of a Complete IV & V Effort (cont)

5) Keys to validation tests

- Validate the build of the executable code
- Validate the integrated code versus the system specifications and identified requirements. (nominal, stress test, and failure mode runs)

6) Keys to quality control

- Have a documented quality system in place
- Be able to record and track

9 Elements of a Complete IV & V Effort (cont)

7) Configuration management
   - Use a rigorous configuration management system to control all versions of documents, databases, code under test, test results and reports

8) Data management
   - Have the ability to automatically report any requirement or flow-down test that is not satisfied completely

9) Code execution
   - For module-level tests and integrated

Methodology
5 Key Steps

Step 1: Review all pertinent documents:

- SW requirements specifications methodology
- SW design methodology
- SW coding standards
- CASE tool documentation
- Test plan and procedure methodology
- SW quality control methodology
- SW configuration management methodology

Methodology (continued)

Step 2: Interview to confirm the intended methodologies:

Step 3: Analyze the methodologies individually & whole

- Each methodology supports the needs of its phase
- Each methodology supports the needs of the program management
- Data and document configuration control are an integral part of the development cycle
- Quality assurance is an integral part of

Methodology

Step 4: Develop a report on the results of the analysis including recommendations for change

Step 5: Support all discussions and corrective actions undertaken to improve the software development methodologies

Criticality Analysis

- Identification of appropriate levels of verific and validation testing

- Reduces costs and schedule by including al software units in detailed tests

Criticality Analysis (cont)

- Several Methods
- One method is computed by identifying:
  - Error impact categories
  - Error occurrence probabilities

  to compute the criticality probabilities
- The results are applied to verification testi determining a criticality threshold
- Below this threshold, verification tests wil performed

Software Criticality Analysis

Error Relationship

Error Impacts	Error Occurrence Probabilities
Negligible	Impossible
Marginal	Improbable
Critical	Probable
Catastrophic	Frequent

Error Impact Categories

Weight	Category	Description
1	Negligible	Causes inconvenience, effort for future updates, no chance of injury, and/or minor cost
2	Marginal	Causes secondary goal degradation, minor, required system update, chance of minor injury, and/or marginal cost
3	Critical	Causes primary operational requirement degradation, major system update, change of moderate injury, and/or critical cost
4	Catastrophic	Causes operational failure, chance of serious injury or death,

Error Occurrence Probabilities

Weight	Category	Description
0	Impossible	Simple and mature; little bearing on overall system performance; well-defined, allocatable, measurable, & testable
1	Improbable	Somewhat complex w/ few interfaces; Relaxed accuracy & precision; some bearing on overall system performance
2	Probable	Moderately coupled and complex w/clearly defined interfaces; moderate accuracy, moderate stress, definite bearing on system performance
3	Frequent	Tightly coupled, complex, numerous interfaces; extreme

Conclusions

- Independence
- Cost Effective Return on Investment
- Rigorous Methodology
- Critical Defect ID

IV&V

QUESTIONS???